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GIFFORD PINCHOT, Forester.

SILVICAL LEAFLET 31.

BLACK HEMLOCK.

Tsuga mertensiana (Bong.) Carr.

Black hemlock is an alpine tree and is important only in the protective forests which, with other species, it forms at the headwaters of mountain streams. It is used very little at present, because it grows at high altitudes where it is inaccessible, although it will probably figure somewhat in the lumber market of the future, since it is suitable for construction timber, and its bark contains tannic acid in paying quantities. As an ornamental tree it is planted both in the United States and in Europe, and ranks among the most beautiful of conifers.

RANGE AND OCCURRENCE.

Black hemlock is found in the timber line forests of the Pacific coast from Alaska to central California, and farther east in southern British Columbia, Montana, and southern Idaho. It is found in its greatest perfection on the slopes below Crater Lake in the Cascade Mountains, where it forms extensive and nearly pure stands.

Throughout its entire range it is a timber-line species. It occurs at sea level at its northern limit, but in its southward extension, owing to its climatic and moisture requirements, it is found at increasingly higher elevations, until in central California it is confined to cold, moist mountain slopes and high valleys at elevations of more than 8,000 feet above the sea.

In Alaska it extends northward in the seacoast forest, which is confined to the coastal plain, hillsides facing the ocean, and stream valleys within from 3 to 5 miles of the sea. On mountain slopes farther inland it ascends to timber line at about 2,000 feet; it often reaches higher altitudes on sheltered south slopes than on north slopes exposed to severe, cold winds.

In the southern part of its range, in Washington, Oregon, northern Montana, Idaho, and California, the best stands of black hemlock are found on flats or gently rolling lands, at the heads of moist valleys, or in sheltered ravines where the snow remains late into the summer. Exposed mountain slopes are less favorable to its best development, although in a more or less stunted condition it is often a characteristic

tree of such slopes. The effect of aspect is especially noticeable in the inland and southern portions of its range. In these regions it shows a decided preference for northerly exposures wherever it leaves the valleys, and at its lower altitudinal limit seems unable to endure the unfavorable conditions of heat and soil moisture which exist on southerly aspects exposed to drying winds and to the full light of the sun.

CLIMATE.

The high altitude at which black hemlock occurs subjects it to a severe alpine climate. In the situations where it is found, daily and seasonal ranges of temperatures are great, owing to the intensity of the sunlight at high elevations and the rapid radiation of heat during the night. The rarity of the air, combined with the relative frequency of high winds, brings about rapid transpiration, although this is modified to some extent by the increased relative humidity due to the low air temperature. The precipitation is chiefly in the form of snow, which is often sufficient to bury the tree completely. The snow comes early and stays late. Its slow melting furnishes a constant supply of moisture through the short growing season. Rains are frequent in spring and fall, but the summers are apt to be hot and dry, especially on southerly exposures.

ASSOCIATED SPECIES.

Black hemlock commonly occurs in mixture with other species, but also forms nearly pure stands of large extent. In places on the coast of Alaska it is associated with Sitka spruce, western hemlock, and alpine fir. As it extends southward, it leaves the spruce and hemlock along the coast and ascends with alpine fir to the high altitudes, where it also mixes with white-bark pine, alpine larch, and Engelmann spruce. From Alaska to central Oregon it frequently associates in the lower part of its altitudinal range with amabilis fir and occasionally with yellow cedar. Amabilis fir occurs in mixture with black hemlock as far south as southern Oregon; the two species sometimes form extensive forests, with fir more abundant on slopes and ridges, and hemlock on flats. Other species present in the mixture are lodgepole pine, lowland fir, western white pine, white-bark pine, and an occasional Engelmann spruce. Absolutely pure stands are uncommon, though there are occasional forests of considerable extent with 85 per cent of black hemlock. Small, pure groups are found most frequently on northerly slopes.

In California it associates at high altitudes with white-bark pine, the mixture often consisting of small, pure groups of each species. At somewhat lower altitudes it mixes with red fir, lodgepole pine, and western white pine. When it grows at an altitude favorable to red fir, the latter usually occupies the slopes, while the hemlock keeps to the gulches.

In the inland or plateau forest of the Kenai Peninsula in southern Alaska white spruce, balm of Gilead, aspen, and birches are its common associates. On the west slopes of the Selkirk Mountains and in the northern Rockies it grows abundantly with western hemlock, alpine fir, white-bark pine, and Engelmann spruce.

HABIT.

Black hemlock is usually a small tree, and seldom grows more than 80 feet high, and from $2\frac{1}{2}$ to 3 feet in diameter. At its best, it attains a height of from 100 to 150 feet, and a diameter of from 4 to 6 feet. In open stands it has a loose, pyramidal crown composed of slender pendant branches with erect tips. The lateral branchlets are drooping and frond-like. In the forest, where the tree reaches its best development, it has a long trunk, often clear for 50 feet, surmounted by a narrow, short, pyramidal crown.

Its growth is comparatively slow, on account of the short growing season at the high altitudes where it occurs, but varies greatly in different situations. The tree may reach merchantable size in from 80 to 250 years.

SOIL AND MOISTURE.

Its best development is attained in soils that are well drained, but not too dry. It requires more moisture than its frequent associate, white-bark pine, and hence is confined to isolated localities, usually in canyons or gulches or along the shady sides of buttes and ridges. In Alaska it replaces western hemlock in cold, wet bogs.

TOLERANCE.

With the exception of western hemlock, none of the associates of black hemlock exceed it in ability to endure shade. The dense shade cast by a clump of hemlock poles is usually sufficient to exclude other species. The seedlings seem to require more light than they can find under the heavy crown cover of mother trees, but thrive in the shade of lodgepole pine. The saplings bear suppression well, and rarely die from this cause. The trees do not clear themselves readily even in dense stands, and when the branches fall they usually leave short stubs which persist in the timber in the form of dead knots.

REPRODUCTION.

Seed bearing begins at about 20 years of age. Seed is borne annually and at times abundantly, but not every year is a good seed year. The cones, which are borne on the upper branches, mature in early October. The seeds are light, possess large wings, and are disseminated by the wind. With sufficient moisture they will germinate on either humous or mineral soil.

The seedlings make better growth in moderate shade and on moist humous soil under a light forest cover than in full light in the open. They occur singly or in groups, and even-aged stands of young growth are often found whose density almost excludes light from the forest floor. Under such conditions growth is slow both in height and diameter, but death from suppression is rare, owing to the great tolerance of the tree.

